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CULTURES WITH MELAMPSORAE ON POPULUS

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Additional cultural results with the *Melampsorae* on species of *Populus* have been secured since the positive results in 1916 on species of *Larix* with the rust known as *Melampsora medusae* Thüm. found on *Populus trichocarpa* and *P. tremuloides*.[1] The telial material on *P. tremuloides* used in 1916 was typical of *M. albertensis* Arth., but owing to the fact that positive results were secured on species of *Larix* only and negative results on *Pseudotsuga taxifolia*[2] is was referred to *M. medusae*.

In April, 1917, a large number of cultures were undertaken for the purpose of checking the two rusts commonly found on *Populus* in the Northwest. The aecial stage known as *M. albertensis* on *Pseudotsuga taxifolia* was found in July, 1916, at Darby, Montana, and at other points, but no successful check cultures had been made for this region up to the present report. The results of the 1917 cultures are presented in Table I. All cultures were made under control conditions in the greenhouse at Missoula, Montana, by the use of celluloid cylinders. An attempt was made to use only those hosts having young susceptible needles.

A study of the data in Table I shows that the sporidia of the rusts known as *M. albertensis* and *M. medusae* infect species of *Larix* and species of *Pseudotsuga* without any apparent preference on the part of either fungus for any particular host genus. Teliospores from a small portion of an infected leaf of collection No. 24 was used to inoculate both *Larix occidentalis* and *Pseudotsuga taxifolia* with positive results in both cases. This was done to eliminate so far as possible the chance of having two species of *Melampsora* on leaves of the same host and included in one collection. In order to check the results obtained from sowing sporidia of *M. medusae* (collection No. 24) on *Pseudotsuga* species the aeciospores thus obtained were sown on young leaves of *Populus trichocarpa*. The leaves were inoculated May 18 and uredinia appeared June 8. Successful inoculations have been secured by sowing some of these urediniospores upon leaves of *Populus trichocarpa*. Inoculations were made on June 9, 1917, and on June 20 abundant uredinial sori were produced. This explains the great abundance of these rusts in regions of few aecial hosts. The proper conclusion of this culture will be to use the telial stage in producing the rust on *Larix*.

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[1] Weir, Jas. R., and Hubert, E. E. Recent cultures of forest tree rusts. Phytopath. 7: 106–109. 1917.

[2] The negative results on *Pseudotsuga taxifolia* in the light of recent work have since been attributed to the use of trial hosts with needles too far advanced in growth. It appears that the youngest and most tender needles are the most susceptible to infection.

Aeciospores resulting from a successful inoculation with collection No. 57 on *Larix occidentalis* were sown June 29, 1917, on young leaves of *Populus trichocarpa*. Uredinia developed in abundance on July 7. No marked differences could be found between the uredinia and urediniospores of this culture and those resulting from an inoculation of *P. trichocarpa* leaves with aeciospores from *Pseudotsuga taxifolia*.

A careful study of the pycniospores and aeciospores resulting from the above cultures was made. These aeciospores on species of *Larix* and on species of *Pseudotsuga* were also compared with aeciospores on *Larix laricina* resulting from an inoculation with telia of *Melampsora medusae* from *Populus deltoides* and *P. tremuloides* cultured by Mains at Ann Arbor, Michigan, May 14, 1914 (N. A. U. No. *1121*). No important differences could be found in comparing the characteristics of these spores. Repeated attempts have been made to find evident differential characters by which the uredinia and telia of these two forms here considsidered may be plainly and readily separated, but with very little success. The first noticeable gross character of *M. albertensis* is that the telia appear to spread out like melted wax while those of *M. medusae* (Fig. 1) are more elevated and conspicuous. The former character of *M. albertensis* only holds good, however, where average-sized leaves of its most common host, viz., *Populus tremuloides* are infected. The rust has been repeatedly collected from large leaves from sprouts at the base of trees which had all the gross characters of *M. medusae* although the average-sized leaves on the parent tree bore the typical form of the rust, *M. albertensis*. These same variations may be noted when the host is *P. trichocarpa*. In regions where the only possible aecial host is *Pseudotsuga taxifolia* the form *M. medusae* will exhibit the same gross variations on *P. trichocarpa* and *P. tremuloides*. It is equally difficult to try to separate the teliospores of these rusts microscopically. The fact that either of them will go on both *Pseudotsuga* and *Larix* irrespective of source or appearance of telia indicates that these rusts which were at first distinguished as *M. medusae* and *M. albertensis* are the different host manifestations of the same rust and should apparently be referred to *Melampsora medusae* Thüm.

Arthur in 1910[3] and in 1911[4] successfully inoculated *Pseudotsuga taxifolia* (*P. mucronata*) with the telial stage of *M. albertensis,* in every case securing negative results on *Larix* spp. As no statement is made regarding the age of the needles used in these inoculations we venture to suggest that the needles of the larches used may have been too old to become infected. This would undoubtedly be the case if the host trees used developed their needles at the same time that trees of similar spcies develop needles in the open. Observations in this locality show that the new needles of *Larix occidentalis* growing in the open were far enough advanced on May 8, 1917, to be susceptible to infection and on the same date the leaf buds of *Pseudotsuga taxifolia* were not even swelling. New susceptible needles of *Pseudotsuga* were not recorded in the open until May 28 and later June 8. On June 8 the aecial stage of the rust was found near Missoula, Montana, on *Larix occidentalis,* while adjacent trees of *Pseudotsuga taxifolia* were just forming new needles. The host trees, used in the inoculation experiments here recorded and kept in the greenhouse since the preceding two seasons, developed new needles at earlier dates than those recorded for similar trees in the open. In the majority of cases the newly-formed needles were the only ones on the trial host which became infected.

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[3] Arthur, J. C. Cultures of Uredineae in 1910. Mycologia 4: 7–33. 1912.

[4] Arthur, J. C. Cultures of Uredineae in 1911. Mycologia 4: 49–65. 1912.

TABLE I

INOCULATION DATA FOR RUSTS ON POPULUS SPECIES

Collection No.	Inoculating Material.—Telia.	Locality of Telial Collection.	Species Inoculated.	No. Plants Inoculated.	Date Inoculation 1917.	Pycnia.	Aecia.	Degree of Infection.
8073	*Melampsora medusae* on *Populus trichocarpa*	Missoula, Montana	*Larix europea*	1	May 3	May 17	May 21	Medium
8073	Ditto	Ditto	*Pseudotsuga taxifolia*	1	May 8	May 18	May 23	Heavy
20	*Melampsora albertensis* on *Populus tremuloides*	Spokane, Wash.	*Larix occidentalis*	2	April 16	April 26	May 2	Heavy
20	Ditto	Ditto	Ditto	1	April 30	May 14	May 21	Heavy
20	Ditto	Ditto	*Larix europea*	1	April 26	May 8	May 14	Heavy
20	Ditto	Ditto	*Pseudotsuga taxifolia*	1	April 17	May 7	May 31	Heavy
20	Ditto	Ditto	Ditto	1	April 19	May 7	May 14	Heavy
20	Ditto	Ditto	Ditto	1	April 23	May 7	May 13	Very heavy
20	Ditto	Ditto	*Pseudotsuga macrocarpa*	1	April 21	May 12	May 19	Heavy
20	Ditto	Ditto	*Larix lyallii*	2	April 16	April 27	May 8	Heavy
20	Ditto	Ditto	*Tsuga heterophylla*	1	April 19	0	0	Negative
24	*Melampsora medusae* on *Populus trichocarpa*	Ditto	*Larix occidentalis*	1	April 26	May 8	May 17	Medium
24	Ditto	Ditto	*Larix lyallii*	1	April 27	May 14	No aecia	Medium
24	Ditto	Ditto	*Pseudotsuga taxifolia*	1	April 26	May 7	May 14	Heavy
40	Ditto	Darby, Montana	Ditto	1	May 18	May 29	June 2	Heavy
43	Ditto	Ditto	*Larix occidentalis*	1	May 18	May 29	June 3	Heavy
43	Ditto	Ditto	*Pseudotsuga macrocarpa*	1	May 17	0	0	Negative. Needles too old
49	*Melampsora albertensis* on *Populus tremuloides*	Pattee Creek, Missoula, Montana	*Larix occidentalis*	2	May 20	May 29	June 2–3	Heavy
49	Ditto	Ditto	*Pseudotsuga macrocarpa* (old needles)	1	May 20	—	—	No result. Needles too old
57	*Melampsora medusae* on *Populus trichocarpa*	Grant Creek, Missoula	*Pseudotsuga taxifolia*	1	June 11	June 20	June 26	Heavy
57	Ditto	Ditto	*Larix occidentalis*	1	June 11	June 20	June 24	Heavy
58	Ditto	Boulder, Montana	*Pseudotsuga taxifolia*	1	June 14	June 24	June 29	Heavy
58	Ditto	Ditto	*Larix occidentalis*	1	June 14	0	0	No result. Needles too old
33	*Melampsora albertensis* on *Populus tremuloides*	Darby, Montana	*Pseudotsuga taxifolia*	1	May 8	May 21	May 27	Medium

An interesting feature of the pycnial stage of the *Melampsorae* is a pronounced and characteristic odor evident at the time the pycnia are expelling spores. Exudations of a clear liquid also accompany this stage and are found to be sweet to the taste. These characters are possessed by the pycnial stage of a number of other forest trees and field plant rusts. The odor of the pycnial stage of *Melampsorella elatina* (A. & S.) Arth. on *Abies* spp., *Peridermium coloradense* (Dietl.) A. & K. on *Picea engelmanni,* and *Puccinia monoica* (Pk.) Arth. on *Arabis kochii* is particularly noticeable. The pycnial odor of the *Melampsorae* is fragrant, while that of *Peridermium coloradense* is decidedly offensive, approaching the odor given out by certain Nymphaeas.

SUMMARY

The results of the present investigation show that the rusts on *Populus* which were heretofore distinguished as *Melampsora medusae* and *M. albertensis* will infect both *Pseudotsuga* and *Larix*. In the absence of sharp differential characters between these two forms, both in their gross and minute details, it is suggested that they are the different host manifestations of the same rust and should apparently be referred to *Melampsora medusae* Thüm.

Two new hosts for this rust are recorded, viz., *Larix lyalli* and *Pseudotsuga macrocarpa.*

New and interesting features attending the production of pycnia in the *Melampsorae* are reported.

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